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upon receipt of that report.*(54) Title: **WATER-DISPERSIBLE NONWOVEN FABRICS CONTAINING TEMPERATURE-SENSITIVE OR ION-SENSITIVE
POLYMERIC BINDER MATERIALS AND PROCESS FOR MAKING SUCH FABRICS**

(57) Abstract

The present invention is directed to a temperature-sensitive or ion-sensitive binder composition containing at least one temperature-sensitive or ion-sensitive polymeric material. The binder composition is either (1) insoluble in water containing greater than about 0.5 weight percent monovalent ions or water having a multivalent ion concentration greater than about 200 ppm multivalent ions, and soluble in water containing less than about 0.5 weight percent monovalent ions or water having a multivalent ion concentration less than about 200 ppm multivalent ions; or (2) insoluble in water having a temperature of greater than about 30 °C, and soluble in water having a temperature of less than about 25 °C. The present invention is further directed to a water-dispersible nonwoven fabric containing the temperature-sensitive or ion-sensitive binder material, which is useful in the manufacture of flushable personal care products. A process for making water-dispersible nonwoven fabrics is also provided.

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10 WATER-DISPERSIBLE NONWOVEN FABRICS CONTAINING
TEMPERATURE-SENSITIVE OR ION-SENSITIVE
POLYMERIC BINDER MATERIALS AND PROCESS FOR
MAKING SUCH FABRICS

15 FIELD OF THE INVENTION

The present invention relates to water-dispersible nonwoven fabrics. In a more specific aspect, the present invention relates to water-dispersible nonwoven fabrics, which contain temperature-sensitive or ion-sensitive polymeric binder materials. The present invention also relates to a process for the manufacture of such water-dispersible nonwoven fabrics.

BACKGROUND OF THE INVENTION

25 Personal care products (such as diapers, sanitary napkins, wipes, wound dressings, bandages, nursing pads and adult incontinence garments) are generally constructed from a number of different components and materials. Principal materials in personal care products are the coverstock (i.e., liner) and the intake (i.e., surge) materials, which are commonly comprised of nonwoven fabrics. For purposes of this application, the terms "nonwoven fabrics", "nonwoven fibrous webs", "fabrics", "fabric webs" and "fibrous substrates" may be used interchangeably and include methods of making such fabrics and webs, such as meltblowing, melt spinning, air laying and wet laying methods.

35 The surge material must be constructed to receive and absorb various liquids, and the liner material must be constructed to prevent or at least minimize the exudation of such liquids.

40 Although personal care products are relatively inexpensive, sanitary and easy to use, the proper disposal of a soiled product is not without problems. With greater interest being placed

5 in protecting the environment today, there is a need to develop
materials that are more compatible with the existing and developing
water disposal technologies while still delivering the performance
which consumers have come to expect and demand. An ideal
10 disposal alternative would be to use municipal sewage treatment
and private residential septic systems. Products suited for disposal
in sewage systems can be flushed down a convenient toilet and are
termed "flushable." To function effectively as liner and surge
materials, nonwoven fabrics must maintain their structural integrity
and exhibit satisfactory tensile strength when wet or damp.
15 However, if nonwoven fabrics were to lose substantially all of their
tensile strength when exposed to water and become dispersible in
such water, the disposal problem could be substantially eliminated.
These materials could then be conveniently flushed down a
conventional toilet system.

20 Desirably, the nonwoven fabrics possess a number of
characteristics, such as softness and flexibility. The fabric is usually
formed by wet or dry laying a random plurality of fibers, which are
then joined together to form a coherent web. Unfortunately, in an
attempt to provide nonwoven fabrics having certain in-use
25 characteristics, prior methods have rendered the fabric non-
dispersible in water. For example, nonwoven fabrics have been
bonded with fluid-insoluble resins which impart in-use strength.
However, such resins impede flushing the fabric by rendering the
fabric substantially water insoluble.

30 With regard to pre-moistened wipes, special problems
arise. The wipes, which are used for skin cleansing and are known
commercially as towelettes, wet wipes or fem-wipes, are formed
from paper or nonwoven fibrous webs treated with a polymeric
binder. The binder imparts to the web a degree of wet strength so
35 that the web will maintain tensile strength while being stored in an
appropriate liquid medium. However, after the wipe has been used,
the binder should be readily weakened when exposed to an
aqueous environment, such as a toilet, without clogging the toilet
and plumbing.

5 Various binders have been used in the manufacture of
a wipe. For example, wipes have included as a binder an acid-
insoluble, alkali-soluble polymeric polycarboxylic acid and
functional derivatives thereof wherein the acid is placed in water
10 and enough alkali is added to substantially neutralize all acidic
groups prior to applying the binder to the web. The binder-
saturated web is dried and then immersed in a low pH medium
where the web retains its structural integrity yet will still break up
when the wipe is immersed in a sufficiently high pH liquid medium.

15 Another binder used for a pre-moistened wipe has
been polyvinyl alcohol combined with a gelling or insolubilizing
agent such as borax. The borax crosslinks at least the surface of
the polymer binder before drying the web to give a water resistant
web. Such cross-links are reversible, that is, when the
20 concentration of borax is reduced below a certain level, the degree
of cross-linking is so low that the binder becomes soluble in water.
However, boron-containing solutions are unacceptable for personal
care products due to safety concerns.

25 Yet another water-dispersible nonwoven fabric has
used a water-soluble binder comprising a partially neutralized
unsaturated carboxylic acid/unsaturated carboxylic acid ester
copolymer. A problem with this binder is that to prevent the
nonwoven fibrous fabric from disintegrating prior to disposal, the
wipe must be maintained in a solution having a pH which may
cause irritation to the skin when the wipe is used.

30 Binders containing carboxylate groups have worked
well for making a water-dispersible fibrous web that is, to a limited
degree, water soluble, water-dispersible or water-disintegratable in
an aqueous environment, provided the water is predominantly void
of divalent ions. However, in those areas where the water is
35 "moderately hard", because the water contains divalent ions such
as calcium ions or magnesium ions, the wipes do not readily
disperse. The water soluble polymeric binder is substantially
rendered insoluble by the presence of divalent ions. It is believed
that the divalent ions crosslink the binder and prevent the binder
40 from dispersing in the water. The adverse effect that divalent ions

5 present in the aqueous environment has on the water solubility of the polymeric binder has not been recognized.

Accordingly, there is a need for a water-dispersible binder composition that can be used in a personal care product, such as a wipe, that is safe to use and will be substantially unaffected by the present of divalent ions normally found in moderately hard water.

SUMMARY OF THE INVENTION

15 Briefly described, the present invention provides a water-dispersible nonwoven fabric, which can be used in flushable personal care products. More specifically, the present invention provides a water-dispersible nonwoven fabric, which contains a temperature-sensitive or ion-sensitive polymeric binder material.

20 The present invention also provides a process for the manufacture of water-dispersible nonwoven fabrics in which the fibers used to form the nonwoven fabrics are bound together with a temperature-sensitive or ion-sensitive polymeric binder material.

The present invention further provides flushable personal care products, which are made from the water-dispersible nonwoven fabrics provided by the present invention.

25 These and other objects, features and advantages of this invention will become apparent from the following detailed description.

30 DETAILED DESCRIPTION OF THE INVENTION

The present invention is directed to binder compositions, which may be used to produce nonwoven fabrics for use in flushable personal care products. The binder compositions possess unique properties, which enable the production of "water-dispersible" products. The binder compositions of the present invention are "ion-sensitive", "temperature-sensitive", or both ion and temperature-sensitive materials. In order to be an effective "ion-sensitive" or "temperature-sensitive" material suitable for use

5 in flushable personal care products, the binder composition should desirably be (1) functional, i.e., maintain wet strength under controlled conditions and dissolve or disperse rapidly in soft or hard water such as found in a toilets and sinks around the world; (2) safe (not toxic); and (3) economical.

10 As used herein, the term "ion-sensitive" refers to the solubility and dispersibility of a binder composition, which varies depending upon the amount of monovalent and/or multivalent ions present in an aqueous solution. As used herein, the term "monovalent" refers to ions having a charge of 1, such as Na^+ and Cl^- ions. As used herein, the term "multivalent" refers to ions having a charge of greater than 1, such as Ca^{2+} and CO_3^{2-} ions. In 15 the present invention, the "ion-sensitive" binder compositions remain insoluble in aqueous compositions having a monovalent salt concentration greater than about 0.5 weight percent or a multivalent ion concentration containing greater than about 200 ppm. However, the "ion-sensitive" binder compositions become 20 soluble in aqueous compositions having a monovalent salt concentration less than about 0.5 weight percent or a multivalent ion concentration containing less than about 200 ppm.

25 In order to be effective as a binder material in flushable products throughout the United States, the ion-sensitive binder compositions of the present invention remain stable and maintain their integrity while dry or in high concentrations of monovalent and/or multivalent ions, but become soluble in water 30 containing up to about 200 ppm Ca^{2+} ions. Desirably, the ion-sensitive binder compositions of the present invention are insoluble in a salt solution containing at least about 0.5 weight percent of one or more inorganic and/or organic salts containing monovalent and/or multivalent ions. More desirably, the ion-sensitive binder 35 compositions of the present invention are insoluble in a salt solution containing from about 0.5 wt% to about 5.0 wt% of one or more inorganic and/or organic salts containing monovalent and/or multivalent ions. Even more desirably, the ion-sensitive binder compositions of the present invention are insoluble in a salt solution 40 containing from about 0.5 wt% to about 3.0 wt% of one or more

5 inorganic and/or organic salts containing monovalent and/or multivalent ions. Suitable monovalent and/or multivalent ions include, but are not limited to, Na^+ ions, K^+ ions, Li^+ ions, NH_4^+ ions, Cl^- ions, Ca^{2+} ions, Mg^{2+} ions, Zn^{2+} ions, CO_3^{2-} ions, SO_4^{2-} ions, and a combination thereof.

10 Based on a recent study conducted by the American Chemical Society, water hardness across the United States varies greatly, with CaCO_3 concentration ranging from near zero for soft water to about 500 ppm CaCO_3 (about 200 ppm Ca^{2+} ion) for very hard water. To ensure polymer dispersibility across the United States, the ion-sensitive binder compositions of the present invention are desirably soluble in water containing up to about 50 ppm Ca^{2+} and/or Mg^{2+} ions. More desirably, the ion-sensitive binder compositions of the present invention are soluble in water containing up to about 100 ppm Ca^{2+} and/or Mg^{2+} ions. Even more desirably, the ion-sensitive binder compositions of the present invention are soluble in water containing up to about 150 ppm Ca^{2+} and/or Mg^{2+} ions. Even more desirably, the ion-sensitive binder compositions of the present invention are soluble in water containing up to about 200 ppm Ca^{2+} and/or Mg^{2+} ions.

25 Further, as used herein, the term "temperature-sensitive" refers to the solubility and dispersibility of a binder composition, which varies depending upon the temperature of an aqueous solution. In the present invention, the "temperature-sensitive" binder compositions remain insoluble in aqueous compositions having a temperature greater than about 37 °C. However, the "temperature-sensitive" binder compositions become soluble in aqueous compositions having a temperature less than about 20 °C. Desirably, the "temperature-sensitive" binder compositions remain insoluble in aqueous compositions having a temperature greater than about 32 °C, and become soluble in aqueous compositions having a temperature less than about 22 °C. More desirably, the "temperature-sensitive" binder compositions remain insoluble in aqueous compositions having a temperature greater than about 30 °C, and become soluble in aqueous compositions having a temperature less than about 25 °C.

5 The binder compositions of the present invention
comprise at least one polymeric material, which is ion-sensitive,
temperature-sensitive, or both. Suitable ion-sensitive and/or
temperature-sensitive polymeric materials include, but are not
10 limited to, poly(vinyl alcohol), poly(vinyl methyl ether),
hydroxypropyl cellulose, alkyl hydroxypropyl cellulose, such as
methyl hydroxypropyl cellulose, and combinations thereof. The
binder compositions of the present invention comprise up to 100
weight percent of at least one ion-sensitive and/or temperature-
15 sensitive polymeric material. Desirably, the binder compositions of
the present invention comprise from about 25 to about 99 weight
percent of at least one ion-sensitive and/or temperature-sensitive
polymeric material and from about 75 to about 1 weight percent of
at least one "other polymer." As used herein, the term "other
20 polymer" refers to polymer, which do not have either the ion-
sensitive or the temperature-sensitive property as described above.
More desirably, the binder compositions of the present invention
comprise from about 40 to about 95 weight percent of at least one
ion-sensitive and/or temperature-sensitive polymeric material and
25 from about 60 to about 5 weight percent of at least one other
polymer. Even more desirably, the binder compositions of the
present invention comprise from about 40 to about 75 weight
percent of at least one ion-sensitive and/or temperature-sensitive
polymeric material and from about 60 to about 25 weight percent
30 of at least one other polymer.

30 Suitable other polymers include, but are not limited to,
water-soluble binders such as polyvinyl alcohol, aqueous dispersions
of, for example, polyvinyl chloride, polyacrylates, and copolymers
of acrylates and methacrylates; polystyrene, styrene-acrylonitrile
35 copolymer, acrylonitrile-butadiene-styrene terpolymer, ethylene-
acrylic acid copolymer, ethylene-methacrylic acid copolymer,
polyolefins grafted with polar functional groups such as hydroxyl
groups, polyacrylates, polymethacrylates, polyvinyl butyral,
polyurethanes, polyesters, polyamides, polyvinyl acetate,
polyethylene vinyl acetate, ethylene-vinyl alcohol copolymer, and
40 combinations thereof. It should be noted that all grades of

5 polyvinyl alcohol may be used as the other polymer, including
water-insoluble grades. Desirably, the other polymer comprises
one or more water-soluble binders such as polyvinyl alcohol,
polyvinyl acetate, polyvinyl chloride, polyacrylates, and copolymers
10 of acrylates and methacrylates. The choice and number of suitable
other polymers to be blended with the ion-sensitive and/or
temperature-sensitive polymeric material is not limited, as long as
the resulting binder composition blend possesses desired properties
(i.e., ion-sensitive and/or temperature-sensitive solubility,
15 dispersibility in cold water, etc.) suitable for use in water-dispersible
products.

In accordance with one embodiment of the present
invention, the binder composition comprises from about 25 to
about 99 weight percent of at least one polymeric material selected
20 from poly(vinyl alcohol), poly(vinyl methyl ether), and methyl
hydroxypropyl cellulose; and from about 75 to about 1 weight
percent of polyvinyl acetate.

In some embodiments, it may be desirable to employ
one or more additives to the binder compositions of the present
invention. Suitable additives include, but are not limited to,
25 antioxidants, antistatic agents, blowing agents, compatibilizers,
flame retardants, heat stabilizers, impact modifiers, lubricants,
plasticizers, ultraviolet stabilizers, processing aids, dispersants, slip
agents, perfumes, colorants, antifoams, bactericides, bacteriostats,
surface active agents, thickening agents, fillers, etc., depending on
30 the specific properties desired in the binder composition and
products made therefrom. Typically, such additives are
incorporated into the binder compositions of the present invention
in an amount up to about 10 weight percent of total weight percent
of the binder composition.

35 In one embodiment of the present invention, a
plasticizer is incorporated into the above-described binder
compositions. Suitable plasticizers include, but not limited to,
glycerol; sorbitol; emulsified mineral oil; dipropyleneglycol di-
benzoate; polyglycols such as polyethylene glycol, polypropylene
40 glycol and copolymers thereof; decanoyl-N-methylglucamide;

5 tributyl citrate; and tributoxyethyl phosphate may be added to the solution containing the binder composition.

10 One advantage of the polymeric binder compositions of the present invention is their relative insensitivity toward divalent cations found in hard water because of the lack of cross-linking sites along the ion-sensitive and/or temperature-sensitive polymeric materials of the compositions. Unlike other binder compositions, the binder compositions of the present invention find versatile applicability to a variety of end uses due to the unique properties of the binder materials.

15 The binder compositions of the present invention are particularly useful in making "water-dispersible" nonwoven fabrics. As used herein, the term "water-dispersible" refers to the ability of a fabric to disintegrate and/or disperse into pieces of fabric when agitated in water having a low ion content (i.e., water having a monovalent salt concentration less than about 0.5 weight percent or a multivalent ion concentration containing less than about 200 ppm) or in cold water (i.e., below about 25 °C). Desirably, the water-dispersible fabric separates into multiple pieces each having an average size of less than about 50%, desirably less than about 40%, and more desirably less than about 30%, relative to the pre-dispersed size within about 20 minutes, and desirably within about 10 minutes, and more desirably within about 2 minutes in an aqueous environment. As used herein, the term "nonwoven fabric" refers to a fabric that has a structure of individual fibers or filaments randomly arranged in a mat-like fashion. Nonwoven fabrics can be made from a variety of processes including, but not limited to, air-laid processes, wet-laid processes, hydroentangling processes, staple fiber carding and bonding, and solution spinning.

30 Nonwoven fabrics prepared in accordance with the present invention have good dry tensile strength, but readily disperse in water having a low ion content or a low temperature. The nonwoven fabrics are abrasion resistant and retain significant tensile strength in aqueous solutions, which either contain a high concentration of salt or have a temperature above the "trigger temperature" of the polymeric material. As used herein the phrase

35

40

5 "trigger temperature" refers to the lower critical solution
temperature (LCST) or the cloud point temperature of the
temperature-sensitive polymeric material. In one embodiment of
the present invention, the polymeric material may be further
10 insolubilized by adding an appropriate organic solvent to the water
to form a "non-cosolvency effect." As used herein, the phrase
"non-cosolvency effect" refers to the formation of a "poor co-
solvent" (i.e., a mixture of two or more solvents in which the
solubility of a given polymeric material is very low) from two or
more "good solvents" (i.e., solvents in which the given polymeric
15 material has good solubility, when the solvents are separate from
one another). Suitable organic solvents for forming a non-
cosolvency effect include, but are not limited to, methanol and
ethanol.

20 Desirably, the nonwoven fabrics of the present
invention are readily dispersible in soft to moderately hard water.
As used herein, the term "soft water" refers to water having a
divalent ion content of less than about 10 ppm. As used herein, the
term "moderately hard water" refers to water having a divalent
ion content of from about 10 to about 50 ppm. As used herein, the
25 term "hard water" refers to water having a divalent ion content of
more than about 50 ppm. Because of this latter property, the
nonwoven fabrics of the present invention are well suited for
disposable personal care products such as sanitary napkins, diapers,
and dry and pre-moistened wipes, which can be thrown in a flush
30 toilet after use.

The binder materials are particularly useful for binding
fibers of air-laid nonwoven fabrics. These air-laid materials are
particularly useful for a variety of products including, but not
limited to, body-side liners, fluid distribution materials, fluid in-take
35 materials (such as a surge material) and absorbent wrap sheet and
cover stock for various water-dispersible personal care products.
Air-laid materials are particularly useful for use as a pre-moistened
wipe. The basis weights for these air-laid non-woven fabrics will
desirably range from about 20 to about 200 grams per square
40 meter (gsm). Surge or in-take materials, which need better

5 resiliency and higher loft, desirably comprise staple fibers having
about 6 denier or greater to make these products. A desirable final
density for the surge or in-take materials is between about 0.025
grams per cubic centimeter (g/cc) to about 0.050 g/cc. Fluid
10 distribution materials will have a higher density, desirably in the
range of about 0.10 to about 0.20 g/cc using fibers of lower denier.

 The nonwoven fabrics of the present invention
may be formed of natural fibers, synthetic fibers and combinations
thereof. The choice of fibers depends upon, for example, fiber cost
and the intended end use of the finished fabric. Examples of
15 suitable fibrous substrates, which can be used alone or in any
combination, include, but are not limited to, cotton, linen, jute,
hemp, wool, wood pulp, regenerated cellulosic fibers such as
viscose rayon, modified cellulosic fibers such as cellulose acetate, or
synthetic fibers derived from polyvinyl alcohol, polyesters,
20 polyamides, polyacrylics, etc. Blends of one or more of the above
fibers may also be used. In one embodiment of the present
invention, a combination of wood pulp and synthetic man-made
fibers is used to form a nonwoven fabric. Desirably, the synthetic
man-made fibers have a fiber denier of less than about 1.5.

25 In a further embodiment of the present invention, the
nonwoven fabric is formed from relatively short fibers, such as
wood pulp fibers. The minimum length of the fibers depends on
the method selected for forming the nonwoven fabric. For
example, where the fibrous substrate is formed by carding, the
30 length of the fiber should usually be at least about 42 mm in order
to insure uniformity. Where the fibrous substrate is formed by air-
laid or wet-laid processes, the fiber length may desirably be about
0.1 millimeters to 15 millimeters. Although fibers having a length
of greater than 50 mm are within the scope of the present
35 invention, it has been determined that when a substantial quantity
of fibers having a length greater than about 15 mm is placed in a
flushable fabric, though the fibers will disperse and separate in
water, their length tends to form "ropes" of fibers which are
undesirable when flushing in home toilets. Therefore, for these
40 products, it is desired that the fiber length be about 15 mm or less

5 so that the fibers will not have a tendency to "rope" when they are
flushed through a toilet. Although fibers of various length are
applicable in the present invention, desirably fibers are of a length
10 less than about 15 mm so that the fibers disperse easily from one
another when in contact with water, most desirably ranging from
about 6 mm to about 15 mm in length. Desirably, the nonwoven
fabrics of the present invention have a relatively low wet cohesive
strength in tap water and sewer water, so that the fabric will break
up readily from the agitation provided by flushing and moving
through the sewer pipes.

15 The nonwoven fabrics of the present invention may be
formed from a single layer or multiple layers. In the case of
multiple layers, the layers are generally positioned in a juxtaposed
or surface-to-surface relationship and all or a portion of the layers
may be bound to adjacent layers. The nonwoven fabric may also
20 be formed from a plurality of separate nonwoven fabrics wherein
the separate nonwoven fabrics may be formed from a single or
multiple layers. The binder may be distributed on the nonwoven
fabric as a single application or where there are multiple layers,
each individual layer may be separately subjected to a binder
25 application and then combined with other layers in a juxtaposed
relationship to form the finished nonwoven fabric.

Another embodiment of the present invention is a
process of making a water-dispersible nonwoven fabric. The
method includes the steps of contacting the fibrous substrate with
30 an effective amount of the binder composition of the present
invention to bind a substantial amount of the fibers and then drying
the fabric to form a water-dispersible fibrous fabric. For ease of
applying the binder to the nonwoven fabric, the binder may be
emulsified, dispersed and/or dissolved in water or another solvent
35 such as methanol, ethanol or the like, with water being the
preferred solvent. The binder desirably has from about 1 to about
50 weight percent solids, and more desirably from about 2.5 to
about 20 weight percent solids.

40 The binder material may be applied to the nonwoven
fabric by any known process of application, such as by spraying,

5 dipping, printing, coating or any other technique. When the binder
is applied to the nonwoven fabric to retain the integrity of the
fabric, the binder is desirably, uniformly dispersed in substantially
all of the fabric to cover substantially all of the fiber junctions.
Based of the total weight of the nonwoven fabric, desirably the
10 binder may be distributed or "added on" to the nonwoven fabric
in an amount of from about 1 to about 50 weight percent, more
desirably from about 5 to about 30 weight percent, even more
desirably from about 8 to about 25 weight percent, and even more
desirably from about 12 to about 18 weight percent.

15
Once the binder composition is applied to the fabric,
the fabric may be dried by conventional means. Once dry, the
coherent fibrous fabric exhibits improved tensile strength when
20 compared to the tensile strength of a similar but untreated wet-laid
or dry-laid fabric. For example, the tensile strength of the fabric
may be increased by at least 25 percent compared to the tensile
strength of the untreated fabric. More particularly, the tensile
strength of the fabric may be increased by at least about 100
25 percent and even more particularly the tensile strength of the fabric
may be increased by at least about 500 percent as compared to an
untreated fabric. However, and quite advantageously, the fabric
will disintegrate or is disintegratable when placed in soft to
moderately hard water, or cold water, and agitated.

30 The water-dispersible nonwoven fabrics of the present
invention are particularly suitable for use in water-dispersible
products. Suitable products include, but are not limited to, wipes,
sanitary napkins, diapers, surgical dressings, tissues, and the like. In
many products, particularly personal care products, nonwoven
35 fabrics are preferred due to their absorptivity of fluids such as
blood, menses and urine. The nonwoven fabrics of the present
invention may be incorporated into a variety of body fluid-
absorbing products including, but not limited to, sanitary napkins,
diapers, surgical dressings, tissues, and the like. The binder
40 compositions of the present invention enable the resulting

5 nonwoven fabrics to remain intact when contacted by body fluids,
since the concentration of divalent ions in the body fluids is above
the level of dissolution. The nonwoven fabric retains its structure,
softness and exhibits a toughness satisfactory for practical use.
10 However, the binder dissolves and the fabric disperses when
brought into contact with water having either a low salt
concentration (i.e., below about 0.5 weight percent) or a
temperature about room temperature. In one
embodiment of the present invention, the nonwoven fabrics are in
the form of wipes. The finished wipes may be individually
15 packaged, desirably in a folded condition, in a moisture proof
envelope or package in containers holding any desired number of
pre-folded sheets and stacked in a water-tight package with a
wetting agent applied to the wipe. The wetting agent may
comprise, by weight, from about 10 weight percent to about 400
20 weight percent of the dry weight of the wipe itself. The wipe must
maintain its desired characteristics over the time periods involved in
warehousing, transportation, retail display and storage by the
consumer. Accordingly, shelf life may range from as little as two
months to up to two years.

25 Various forms of impermeable envelopes for
containing wet-packaged materials, such as wipes and towelettes
and the like, are well known in the art. Any of these may be
employed in packaging the pre-moistened wipes of the present
invention.

30 Those skilled in the art will readily understand that the
binder compositions and fibrous substrates of the present invention
may be advantageously employed in the preparation of a wide
variety of products, including but not limited to, absorbent personal
care products designed to be contacted with body fluids. Such
35 products may only comprise a single layer of the fibrous substrate
or may comprise a combination of elements as described above.
Although the binder compositions and fibrous substrates of the
present invention are particularly suited for personal care products,
the binder compositions and fibrous substrates may be
40 advantageously employed in a wide variety of consumer products.

5 Further, although the binder compositions are particularly useful in the formation of nonwoven fabrics, the binder compositions may also be used in the formation of woven or knit fabrics, wherein the binder composition is used as a fiber sizing material or a fabric coating material.

10 The present invention is further illustrated by the following examples, which are not to be construed in any way as imposing limitations upon the scope thereof. On the contrary, it is to be clearly understood that resort may be had to various other
15 embodiments, modifications, and equivalents thereof which, after reading the description herein, may suggest themselves to those skilled in the art without departing from the spirit of the present invention and/or the scope of the appended claims.

20

EXAMPLES

Preparation of Binder Materials:

Binder No. 1:

25 This binder was based on polyvinyl alcohol and comprised the following components given in parts by weight:

157.2 parts of 15 weight percent polyvinyl alcohol marketed under the trade designation KP-6 by Nippon Gohsei Company (15 wt% PVOH and 85 wt% water);

30 42.8 parts of 55 weight percent polyvinyl acetate emulsion marketed under the trade designation VINAC® XX-210 by Air Products, Inc. (55 wt% PVA and 45 wt% water);

192 parts water; and

3.93 parts anhydrous sodium sulfate.

35 Total solids content: 12.0 weight percent.

To dissolve polyvinyl alcohol in water, the desired amount of poly (vinyl alcohol) powder was added slowly to well-agitated hot water at 80-90°C. The hot slurry was allowed to cool to room temperature with continued agitation. The agitation was
40 continued until all particles were dissolved and the solution was free

5 of gel. High shear agitation was necessary to ensure complete dispersion when polyvinyl alcohol was added to water, but was not necessary in the subsequent dissolution step.

10 Alternatively, to dissolve polyvinyl alcohol in water, the desired amount of polyvinyl alcohol was added to water at room temperature with agitation. The agitation was continued until the polyvinyl alcohol was dissolved. In this method, the time factor was more important than high shear to ensure complete solution of the gel particles.

15 To prepare the binder solution, the desired amount of sodium sulfate was dissolved in water, and this solution was then added to the polyvinyl alcohol solution under agitation, followed by the addition of the polyvinyl acetate emulsion. The viscosity of the final binder composition was about 68 centipoises, but this composition was not stable as phase separation occurred over time upon standing. However, a uniform composition was regenerated with agitation.

Binder No. 2:

25 This binder was based on polyvinyl methyl ether and comprised the following components given in parts by weight:

7.50 parts polyvinyl methyl ether solution obtained as a 50 weight percent solids solution under the trade designation LUTANOL® M-40 from BASF Corporation;

30 72.05 parts deionized water; and
20.45 parts polyvinyl acetate emulsion as in

Binder No. 1.

Total solids content: 15.0 weight percent.

35 The polyvinyl methyl ether solution was added to the deionized water at room temperature. After thorough mixing, the polyvinyl acetate emulsion was added with vigorous stirring to obtain a homogeneous mixture. The composition phase separated over time upon standing, but a homogeneous mixture was regenerated upon vigorous agitation. The viscosity of the final binder composition was about 41 centipoises.

5

Binder No. 3:

This binder was based on methyl hydroxypropyl cellulose and comprised the following components given in parts by weight:

10

83.0 parts methyl hydroxypropyl cellulose; and
17.0 parts polyvinyl acetate emulsion as in

Binder No. 1.

Total solids content: 12.0 weight percent.

15

The desired amount of methyl hydroxypropyl cellulose powder (marketed under the trademark BENECEL® MP-943 by Aqualon Chemical Company) was added to deionized water at 70-75°C. Under vigorous agitation, the water temperature was allowed to drop to room temperature. The agitation was continued until all of the powder was in solution.

20

To this solution, the polyvinyl acetate was added with vigorous stirring. The stirring was continued until a homogeneous mixture was obtained. The composition phase separated over time upon standing, but a homogeneous mixture was regenerated upon vigorous agitation. The viscosity of the final binder composition was about 50 to about 200 centipoises.

25

Binder No. 4:

This binder was based on poly(vinyl methyl ether) and comprised the following components given in parts by weight:

30

15.0 parts polyvinyl methyl ether solution as in
Binder No. 2;

71.4 parts deionized water; and

35

13.6 parts vinyl acetate-ethylene emulsion
marketed under the trademark AIRFLEX® 300 by Air Products,
Inc.

Total solids content: 15.0 weight percent.

40

The polyvinyl methyl ether solution was added to the deionized water at room temperature. After thorough mixing, the

5 vinyl acetate-ethylene emulsion was added with vigorous stirring to
obtain a homogeneous mixture. The composition phase separated
over time upon standing, but a homogeneous mixture was
regenerated upon vigorous agitation. The viscosity of the final
10 mixture was between about 40 to about 60 centipoises.

EXAMPLE 1

15 A web containing 75 gsm (grams per square meter) of
a mixture of southern softwood Kraft fluff (SSWK) pulp from
Rayonier (Jesup, GA) and 6 mm/6 d/f (denier per filament)
polyester from KoSa (Charlotte, N.C.) (50:50 weight percent blend)
was sprayed with 25 gsm Binder No. 1 to provide a web with an
overall basis weight of 100 gsm. This material was found to have
some weak areas because of the high viscosity of the binder
20 solution, which prevented good spray coverage of the web.
However, this material was found to have instant wetting capability
and dispersed in cold tap water.

25 Another web containing 90 gsm of the same fiber
mixture was sprayed with a diluted solution of Binder No. 1 at a
level of 10 gsm. Poor spray coverage of the binder was evident
from observing the shallow spray cone angle (about 25°). Good
bulk was achieved (about 3 mm thickness) and low density (0.03 g/cm^3), which are important for designing a good fluid intake
material.

EXAMPLE 2

30 A web containing 95 gsm CEMFIBER® (Varde,
Denmark) polypropylene (6mm/2 d/f) and Rayonier SSWK pulp
(50:50 weight percent blend) was sprayed with 5 gsm Binder No. 1
to provide a web with an overall basis weight of 100gsm. Again,
35 poor binder coverage was observed due to shallow cone spray
angle. The material was found to be cold water dispersible in tap
water.

5

EXAMPLE 3

A web containing 23 gsm CEMFIBER® polypropylene (6mm/2 d/f) formed on a tissue carrier web was sprayed with 2 gsm Binder No. 1 to provide a web with an overall basis weight of 25 gsm. Poor web formation was observed using straight polypropylene fiber, and the binder was found to be mostly transferred to the tissue carrier web, creating a weakly bonded material.

10

A second web was formed using 80 wt% CEMFIBER® polypropylene (6mm/2 d/f) fibers and 20 wt% Rayonier SSWK pulp. The web had improved fiber formation, but the high viscosity of Binder No. 1 left one side of the web bonded and the other side only weakly bonded because of poor penetration.

15

20

EXAMPLE 4

A web containing 28 gsm rayon fibers (available under the tradename TENCEL® from Acordis Cellulosic Fibers, Inc., Mobile, AL) (6mm / 3d/f) and Rayonier SSWK pulp (75:25 weight percent blend) was sprayed with 8 gsm Binder No. 2 on one side to provide a web with an overall basis weight of 36 gsm. Although the web was "harsher" feeling than webs containing polypropylene, instant wettability was significantly improved using Binder No. 2. The web remained intact when hot water (> than 40°C) was poured onto the web, but when placed in cold tap water, the web dispersed rapidly.

25

30

A similar fabric was prepared, but the basis weight of the fiber blend was reduced to 24 gsm and Binder No. 2 was applied at a level of 3 gsm per side. The rayon/pulp fiber makeup with binder applied to both sides was "harsher" to the touch than previous polypropylene based webs.

35

EXAMPLE 5

A web containing 29 gsm CEMFIBER® polypropylene (6mm / 2d/f) and Rayonier SSWK pulp (75:25 weight percent blend) was sprayed with Binder No. 2, 4 gsm per

40

5 side to provide a web with an overall basis weight of 37 gsm. A
second fabric was produced keeping the fiber blend basis weight at
29 gsm, but spraying Binder No. 2 at a 7 gsm level on one side
only to form a web with an overall basis weight of 36 gsm. Even
10 with the polypropylene fibers added to the fiber blend, the webs
seemed somewhat "harsh" to the touch. The added "harshness"
was a result of the poly(vinylacetate) additive in Binder No. 2.
Both webs stayed intact when warm water passed through them,
but broke up rapidly in cold tap water.

15

EXAMPLE 6

A web containing 31 gsm CEMFIBER®
polypropylene (6mm / 2d/f) and Rayonier SSWK pulp (75:25
weight percent blend) was sprayed with 7 gsm of Binder No. 3 on
one side to provide a web with an overall basis weight of 38 gsm.
20 Like Binder No. 1, the high viscosity of Binder No. 3 prevented a
good spray pattern (about 45°) leading to poor coverage of the
binder on the web. This material had good instant wetting
capability, but not as good as Binder No. 2 based webs.

25

EXAMPLE 7

A web containing 31 gsm CEMFIBER®
polypropylene (6mm / 2d/f) and Rayonier SSWK pulp (75:25
weight percent blend) was sprayed with 7 gsm Binder No. 4 on
one side to achieve a web with an overall basis weight of 38 gsm.
30 A second fabric was prepared reducing the fiber blend basis weight
to 27 gsm and spraying both sides of the web with Binder No. 4 at
a level of 3 gsm per side, which provided a web with an overall
basis weight of 33 gsm. This binder exhibited an excellent spray
pattern (cone angle of 90°) and provided good coverage on the
web. The webs were also much softer to the touch, which was
35 attributed to the polyvinylacetate-co-ethylene component in Binder
No. 4, which is less "harsh" than the polyvinylacetate component
in Binder No. 2. Like the webs made with Binder No. 2, webs
made with the Binder No. 4 allowed warm water to pass through
40 without destroying the integrity of the web, but when placed in

5 cold tap water the web quickly disintegrated. These webs were soft to the touch, but did not have adequate integrity. The polyvinylmethylether component in Binder No. 4 was responsible for maintaining integrity in warm water, but allowing the web to break up in cold tap water.

10

EXAMPLE 8

A web containing 90 gsm polyester (6mm / 6d/f) and Rayonier SSWK pulp (50:50 weight percent blend) was sprayed with 5 gsm Binder No. 2 on both sides to provide a web with an overall basis weight of 100 gsm. Binder No. 2 along with the stiff polyester fibers produced a web with good resiliency, high loft (3-4 mm thick), and low density (0.03g/cm^3), which met the desired initial requirements for a fluid intake (surge) material. Upon contact with warm water, the web maintained its resiliency and integrity, but slowly broke up in cold tap water. The polyvinylacetate component in Binder No. 2 was responsible for good web integrity, while the polyvinyl methyl ether provided the trigger mechanism to allow web breakup in cold water.

25

EXAMPLE 9

A web containing 90 gsm polyester (6mm / 6d/f) and Weyerhaeuser NB420 fluff pulp (available from Weyerhaeuser, Federal Way, WA) (50:50 weight percent blend) was sprayed with 5 gsm Binder No. 2 on both sides to provide a web with an overall basis weight of 100 gsm. Like Example 8, the Weyerhaeuser pulp, with the same combination of polyester fibers and Binder No. 2, provided a web that met the desired initial requirements for a intake (surge) material. The purpose of making webs with two fiber types was to investigate later the effect of fiber type on flushability/dispersibility of composite materials and finally personal care products.

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40 The present invention has been described in detail with particular reference to certain embodiments, but variations and

- 5 modifications can be made without departing from the spirit and scope of the invention as defined in the following claims.

5

CLAIMS

What is claimed is:

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1. A temperature-sensitive or ion-sensitive binder composition comprising at least one temperature-sensitive or ion-sensitive polymeric material, wherein (a) the binder composition is insoluble in water containing greater than about 0.5 weight percent monovalent ions or water having a multivalent ion concentration greater than about 200 ppm multivalent ions, and is soluble in water containing less than about 0.5 weight percent monovalent ions or water having a multivalent ion concentration less than about 200 ppm multivalent ions; or (b) the binder composition is insoluble in water having a temperature of greater than about 30 °C, and is soluble in water having a temperature of less than about 25 °C.

2. The binder composition of Claim 1, wherein the binder composition is insoluble in water having a multivalent ion concentration greater than about 200 ppm multivalent ions, and is soluble in water having a multivalent ion concentration of from about 50 ppm to about 200 ppm.

3. The binder composition of Claim 1, wherein the binder composition is insoluble in water having a multivalent ion concentration containing greater than about 200 ppm, and is soluble in water having a multivalent ion concentration of from about 100 ppm to about 200 ppm.

4. The binder composition of Claim 1, wherein the binder composition is insoluble in water having a multivalent ion concentration containing greater than about 200 ppm, and is soluble in water having a multivalent ion concentration of from about 150 ppm to about 200 ppm.

5 5. The binder composition of Claim 1, wherein the binder composition is insoluble in water having a monovalent ion concentration of greater than about 0.5 weight percent and is soluble in water having a monovalent ion concentration of less than about 0.3.

10 6. The binder composition of Claim 1, wherein the binder composition is insoluble in water having a temperature of from about 30 °C to about 37 °C, and is soluble in water having a temperature of from about 25 °C to about 20 °C.

15 7. The binder composition of Claim 1, wherein the binder composition is insoluble in water having a temperature of from about 32 °C to about 37 °C, and is soluble in water having a temperature of from about 25 °C to about 22 °C.

20 8. The binder composition of Claim 1, wherein the binder composition comprises from about 25 to about 99 weight percent of at least one ion-sensitive or temperature-sensitive polymeric material, and from about 75 to about 1 weight percent of at least one other polymer.

25 9. The binder composition of Claim 1, wherein the at least one ion-sensitive or temperature-sensitive polymeric material comprises poly(vinyl alcohol), poly(vinyl methyl ether),
30 hydroxypropyl cellulose, methyl hydroxypropyl cellulose, or a combination thereof.

35 10. A water-dispersible nonwoven fabric comprising fibers and the binder composition of Claim 1.

- 5 11. A water-dispersible nonwoven fabric comprising:
 fibers; and
 a temperature-sensitive or ion-sensitive binder
composition comprising at least one temperature-sensitive or ion-
sensitive polymeric material, wherein (a) the binder composition is
10 insoluble in water having a monovalent ion concentration of greater
than about 0.5 weight percent or a multivalent ion concentration
containing greater than about 200 ppm, and is soluble in water
having a monovalent ion concentration of less than about 0.5
weight percent or a multivalent ion concentration containing less
15 than about 200 ppm; or (b) the binder composition is insoluble in
water having a temperature of greater than about 30 °C, and is
soluble in water having a temperature of less than about 25 °C.
- 20 12. The nonwoven fabric of Claim 11, wherein the binder
composition is insoluble in water having a multivalent ion
concentration greater than about 200 ppm multivalent ions, and is
soluble in water having a multivalent ion concentration of from
about 50 ppm to about 200 ppm.
- 25 13. The nonwoven fabric of Claim 11, wherein the binder
composition is insoluble in water having a multivalent ion
concentration containing greater than about 200 ppm, and is
soluble in water having a multivalent ion concentration of from
about 100 ppm to about 200 ppm.
- 30 14. The nonwoven fabric of Claim 11, wherein the binder
composition is insoluble in water having a multivalent ion
concentration containing greater than about 200 ppm, and is
soluble in water having a multivalent ion concentration of from
35 about 150 ppm to about 200 ppm.

5 15. The nonwoven fabric of Claim 11, wherein the binder composition is insoluble in water having a monovalent ion concentration of greater than about 0.5 weight percent and is soluble in water having a monovalent ion concentration of less than about 0.3.

10 16. The nonwoven fabric of Claim 11, wherein the binder composition is insoluble in water having a temperature of from about 30 °C to about 37 °C, and is soluble in water having a temperature of from about 25 °C to about 20 °C.

15 17. The nonwoven fabric of Claim 11, wherein the binder composition is insoluble in water having a temperature of from about 32 °C to about 37 °C, and is soluble in water having a temperature of from about 25 °C to about 22 °C.

20 18. The nonwoven fabric of Claim 11, wherein the binder composition comprises from about 25 to about 99 weight percent of at least one ion-sensitive or temperature-sensitive polymeric material, and from about 75 to about 1 weight percent of at least
25 one other polymer.

 19. The nonwoven fabric of Claim 11, wherein the at least one ion-sensitive or temperature-sensitive polymeric material comprises poly(vinyl alcohol), poly(vinyl methyl ether),
30 hydroxypropyl cellulose, methyl hydroxypropyl cellulose, or a combination thereof.

 20. A flushable personal care product comprising the water-dispersible nonwoven fabric of Claim 11.

35

5 21. A flushable personal care product comprising a water-dispersible nonwoven fabric, wherein the nonwoven fabric comprises:

 fibers; and

 a temperature-sensitive or ion-sensitive binder
10 composition comprising at least one temperature-sensitive or ion-sensitive polymeric material, wherein (a) the binder composition is insoluble in water having a monovalent ion concentration of greater than about 0.5 weight percent or a multivalent ion concentration containing greater than about 200 ppm, and is soluble in water
15 having a monovalent ion concentration of less than about 0.5 weight percent or a multivalent ion concentration containing less than about 200 ppm; or (b) the binder composition is insoluble in water having a temperature of greater than about 30 °C, and is soluble in water having a temperature of less than about 25 °C.

20 22. The flushable personal care product of Claim 21, wherein the binder composition is insoluble in water having a multivalent ion concentration greater than about 200 ppm multivalent ions, and is soluble in water having a multivalent ion
25 concentration of from about 50 ppm to about 200 ppm.

 23. The flushable personal care product of Claim 21, wherein the binder composition is insoluble in water having a multivalent ion concentration containing greater than about 200
30 ppm, and is soluble in water having a multivalent ion concentration of from about 100 ppm to about 200 ppm.

 24. The flushable personal care product of Claim 21, wherein the binder composition is insoluble in water having a multivalent ion concentration containing greater than about 200
35 ppm, and is soluble in water having a multivalent ion concentration of from about 150 ppm to about 200 ppm.

5 25. The flushable personal care product of Claim 21,
wherein the binder composition is insoluble in water having a
monovalent ion concentration of greater than about 0.5 weight
percent and is soluble in water having a monovalent ion
concentration of less than about 0.3.

10 26. The flushable personal care product of Claim 21,
wherein the binder composition is insoluble in water having a
temperature of from about 30 °C to about 37 °C, and is soluble in
water having a temperature of from about 25 °C to about 20 °C.

15 27. The flushable personal care product of Claim 21,
wherein the binder composition is insoluble in water having a
temperature of from about 32 °C to about 37 °C, and is soluble in
water having a temperature of from about 25 °C to about 22 °C.

20 28. The flushable personal care product of Claim 21,
wherein the binder composition comprises from about 25 to about
99 weight percent of at least one ion-sensitive or temperature-
sensitive polymeric material, and from about 75 to about 1 weight
percent of at least one other polymer.

25 29. The flushable personal care product of Claim 21,
wherein the at least one ion-sensitive or temperature-sensitive
polymeric material comprises poly(vinyl alcohol), poly(vinyl methyl
ether), hydroxypropyl cellulose, methyl hydroxypropyl cellulose, or
a combination thereof.

30 30. The flushable personal care product of Claim 21,
wherein the flushable personal care product comprises a wipe, a
sanitary napkin, a diaper, a surgical dressing, or a tissue.

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